Original article

Prospective analysis of factors affecting the surgical outcomes of pediatric depressed skull fractures

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ABSTRACT

Background: Around 42% of the pediatric patients present with skull fractures and the prognosis depends on several factors including type and location of fracture along with severity of associated brain trauma. The objective of this study was to find the factors affecting the outcome in childhood depressed skull fractures.

Patients and methods: This prospective observational study included 68 patients with depressed fractures presenting in the neurosurgery emergency department of Children Hospital Lahore. After detailed history and routine investigations, patients underwent the standard surgical procedure and were closely observed during the hospital stay. All were followed up for one month after being discharged from the hospital.

Results: The mean age of the children was 7.72±3.80 years. The male-to-female ratio was 1.42:1. Most of the patients had a history of fall (N=39, 57.4%). Twenty-nine (42.6%) had simple and 39 (57.4%) had complex fractures. Mostly presented with injuries at parietal (25%) and frontal (20.6%) region. Forty-seven (69.1%) were having GCS in between 13-15 (mild), 12 (17.6%) in between 9-12 (moderate) and 09 (13.2%) of the children were having GCS ≤8 (severe) at the time of presentation. Regarding outcome, good recovery was noticed in 49 (72.1%) children, moderate disability in 8 (11.8%), severe disability in 4 (5.9%), the vegetative state in 3 (4.4%), and death in 4 (5.9%) of the patients. A strong association was found between the GCS category and outcome of the surgery ($p<0.001$). No significant association was found between outcome and mode of injury ($p=0.45$), site ($p=0.553$), and type of fracture ($p=0.66$).

Conclusion: Children with depressed fractures and a history of trauma normally present with minor brain injury and have a good post-surgical outcome.

Keywords:

Pediatric, Depressed Skull Fractures, Traumatic Brain Injury, Surgical Outcome

INTRODUCTION

Trauma has become more common in both developing and developed countries, especially in overcrowded cities such as Lahore due to heavy traffic flow.[1] Patients have been involved in roadside accidents, falls, and other high-energy collisions leading to different kinds of injuries predominantly head injuries.[2] Depressed skull fractures (DSFs) are one form of severe head injury that occurs when high-kinetic-energy objects (e.g., a baseball bat, hammer, or rock) make contact with the skull over a relatively small area, outer tables of the fracture line is lowered than the usual anatomical location of the inner table leading to increased risk of pressure on the brain thus crushing the fragile tissue.[3,4] Traumatic brain injury is a major concern all over the world. The occurrence of depressed skull fracture is growing in the majority of head injury cases, necessitating skilled professionals and new equipment for improved treatment to save the patients' lives.[5] DSFs account for 42% of the pediatric patients presenting with skull fractures.[6] The prognosis of patients with depressed fractures varies and is dependent on several factors. These considerations include the patient's age and gender distribution, GCS at admission, fracture location, associated brain trauma, fracture type, dural laceration, pneumocephalus, and condition at the time of discharge from the hospital.[4,7] Previous studies report good outcomes noted in 75.4% 60 81% of adult patients with depressed fractures.[8,9] One report conducted this kind of study in pediatric patients and observed good outcomes in 73% of the patients.[6] This study aimed to identify the factors influencing the outcome in cases of depressed skull fracture (DSF). This study will be helpful in pediatric neurosurgery practice for assessing the prognosis of children experiencing depressed skull fractures based on outcome prediction.

PATIENTS AND METHODS

This prospective observational study was carried out from January 2021 to May 2021, in the Pediatric

Conflict of interest: The authors declared no conflict of interest exists.

Citation: Zahid H, Ijaz L, Jamil A, Rehman L, Iqbal S, Khan MMN. Prospective analysis of factors affecting the surgical outcomes of pediatric depressed skull fractures. J Fatima Jinnah Med Univ. 2021; 15(3):118-121.

DOI: https://doi.org/10.37018/SLGB1653

Neurosurgery Emergency, Children Hospital &The Institute of Child Health, Lahore. Approval from the hospital ethical committee was obtained. The sample size of 68 was measured keeping the estimated incidence of depressed skull fracture as 23%, a 10% margin of error, and a 95% confidence interval.[10] Non-probability purposive sampling was used to include patients aged ≤14 years presenting with depressed skull fractures. Patients with meningitis, encephalitis, empyema, shock, bleeding disorders, and history of brain pathology or surgery were excluded. Informed consent was taken from parents or guardians. Following admission to the emergency department, a comprehensive history and evaluation were performed, including assessment of pupillary size/reactivity, and the level of consciousness, the time between the head injury and the presentation, the mode of injury, the type, site, and size of the fracture and presence of related injuries. Baseline pre-operative investigations including CT scan Head with bone window were carried out. Standard Surgical procedure was performed by a single surgical team. Per-operative findings i.e., dural laceration, exact site, and size of fracture or underlying hematoma or contusion were noted. Patients were admitted to the ward or ICU depending on the post-operative condition and during the hospital stay the complications and outcome according to Glasgow Outcome Scale Extended (GOS-E) Peds; good recovery, moderate disability, severe disability, vegetative state, or death were noted.[11]

At the time of discharge, parents were advised to bring patients after one month for follow up. However, in case of any complication, they could return to the hospital anytime during this period. The time between hospital discharge and the development of complications during the follow-up period was noted. The recorded data was entered and evaluated in SPSS version 23. The normality of the data was tested using the Shapiro-Wilk test, and relevant statistical tests were applied with a p-value of ≤0.05 considered significant.

RESULTS

Total 68 children with depressed fracture following head injury were enrolled. Mean age of the children was 7.72±3.80 years, (range 8 months to 14 years). There were 40 (58.8%) male and 28 (41.2%) female children; male-to-female ratio being 1.42:1. Thirty-nine (57.4%) children presented with a history of fall from height, 21 (30.9%) with a road traffic accident, 4 (5.9%) with fight and non-accidental injury, and 4 (5.9%) with a history of penetrating injury (e.g., axe or iron rod injury).

Table 1. Frequency of symptoms at the time of presentation

Symptoms at presentation	Frequency *n* (%)
Vomiting	52 (76.47)
Nasal bleed	37 (54.41)
Loss of consciousness	29 (42.65)
Ear bleed	16 (23.53)
Seizures	11 (16.18)

Table 2. Categorical frequencies of traumatic brain injuries

Category	Frequency *n* (%)
Mild (GCS: 13-15)	47 (69.1)
Moderate (GCS: 9-12)	12 (17.6)
Severe (GCS: ≤8)	9 (13.2)

Twenty-nine (42.6%) children were having simple fractures and 39 (57.4%) were having complex fractures. Seventeen (25%) children presented with parietal injury, 14 (20.6%) with frontal injury, 10 (14.7%) with front-parietal, 11 (16.2%) with temporoparietal, 7 (10.3%) with temporal, 5 (7.4%) with parieto-occipital and 4 (5.9%) presented with occipital injuries. Symptoms at the time of presentations are presented in Table 1.

The minimum size of fracture was 1x1cm and the maximum size of fracture was 6x5cm. The smaller size of fractures was noticed in penetrating injuries and larger sizes were noticed in simple fractures. Twenty-seven (39.7%) patients had associated orbital and maxillo-facial injuries, 16 (23.53%) had limb fractures, 10 (14.17%) had spinal injuries, 8 (11.76%) had thoracic injuries and 6 (8.82%) had abdominal injuries. Twenty-four patients (35.3%) did not have associated injuries. The minimum time interval noticed between the onset of injury and presentation in the hospital was one hour and the maximum was 3 days. More time interval was noticed in patients who presented with simple fractures and had no significant symptoms or associated injuries.

The minimum presenting GCS noticed was 5 and the maximum was 15. Traumatic brain injury of the patients was categorized into mild, moderate, and severe according to their presenting GCS as shown in Table 2.

On CT scan, 26 (38.2%) patients had brain contusions, 19 (27.9%) had pneumocephalus, 14 (20.6%) had an extradural hematoma and 9 (13.2%) had traumatic subarachnoid hemorrhage. During Surgery, the dural laceration was noticed in 37 (54.41%), brain contusion in 32 (47.06%), extradural hematoma in 12 (17.65%), and venous sinus injury were noticed in 7 (10.29%) cases. The mean hospital stay was 4.66±1.87 days range 3-11 days).

Table 3. Distribution of post-operative complications

Post-operative complications	Frequency *n* (%)
Seizures	6 (8.8)
CSF Rhinorrhea / Otorrhea	4 (5.9)
Wound site infection	4 (5.9)
Post-traumatic hydrocephalous	3 (4.4)
CSF leak from wound site	2 (2.9)
Growing skull fracture	2 (2.9)
No complication	47 (69.11)

Mean time interval between the development of complications and discharge was 11.81±4.22 days (range, 3-19 days).

Good recovery was noticed in 49 (72.1%) children, moderate disability in 8 (11.8%), severe disability in 4 (5.9%), the vegetative state in 3 (4.4%), and death in 4 (5.9%) of the patients. Strong association was found between presenting GCS category and outcome of the surgery as all 4 patients who died belonged to severe GCS category (p <0.001). No significant association was found between outcome and mode of injury (p=0.45), site (p=0.553), and type of fracture (p=0.66). A total of 21 patients developed postoperative complications during the hospital stay and after being discharged from the hospital (Table 3).

DISCUSSION

The brain is encased in a meningeal covering and covered within the skull by cerebrospinal fluid (CSF). The fascia and muscles of the scalp also provide extra cushioning to the brain.[12] Although these layers protect the brain, meningeal attachments to the interior of the skull can restrict brain movement and transmit shearing forces to the brain.[13] Depressed skull fractures are usually caused by a high-energy direct impact to a small surface area of the skull with a blunt object. Fragment comminution begins at the point of greatest impact and extends centrifugally. To be clinically relevant and necessitate elevation, a free piece of bone must be depressed more than the adjacent inner table of the skull.[4,14] Mean age of the children in this study was 7.72 years, which is consistent with a similar study in Pakistan in which authors reported a mean age of 6.91 ±1.84 years, and Arneitz and coworkers who reported a mean age of 5.9 years in their study.[5,6] The male-to-female ratio was 1.42:1, which was similar to 1.49:1 in children with depressed fractures [6] and close to 2.42:1 in elderly patients.[8] Major cause of skull fractures in this study was fall (57.4%). Previous study reported that 79 percent of patients with depressed skull fractures have a history of a fall. The explanation for this disparity may be due to the larger sample size in their analysis (5217 vs 68 in current study).[5] This proportion is, however, like a survey by Ali and coauthors and Muhammad and colleagues, who found that 46.67 percent and 50.6 percent of people have a history of fall, respectively.[6,15]

In this study, 25% of the children had an injury in the parietal region and 20.6 percent had an injury in the frontal region. For parietal and frontal sites of injury, these findings vary from those of Arneitz and coworkers (77%, 6%) Muhammad and associates, (63.1%, 12.5%), Rehman and colleagues (47.7%, 36.9%), and Ali and coauthors (16.67%, 20%) for parietal and frontal sites of injuries.[5,6,8,15] The outcome of the patients i.e., good recovery of the patients (72.1%) in this study is also comparable with previous studies.[6,8] It is worth noting that seven of the patients in this study encountered complications even after being discharged from the hospital. It indicates that complications can arise at any point during a patient's care.

Limitations in this study is smaller patient sample size. For a better understanding of the subject, a larger sample size and a longer time should be conducted. Patients were followed for one month only. A longer follow-up would provide more information.

CONCLUSION

Depressed fractures in children are often associated with mid-traumatic brain injury, and the patients' outcomes are often particularly good. However, full treatment during the hospital stays and good follow-up after discharge are needed for better patient management.

Acknowledgment: We acknowledge Dr. Junaid Rashid Technical Officer, Chief Executive Office District Lahore for helping us in data analysis.

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